Vulnerability Analysis Methodology

Loss estimated provided herein uses available data and applicable methodologies that result in an approximation of risk. These estimates should be used to understand relative risk from hazards and potential losses. Uncertainties are inherent in any loss estimation methodology, arising in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Numerous uncertainties also result from approximation and simplifications that are necessary for a comprehensive analysis these may include incomplete inventories, demographic, economic parameters, or lack of data. A basic synopsis of the methodology utilized to meet the requirements in DMA 2000 is discussed here with a more detailed discussion in each hazard section.

Geographic Information System (GIS) software was used as the basic analysis tool to complete the hazard analysis in all seven multi-jurisdictional plans and the state plan. For most hazards, a comparison was made between available digital hazard data and census 2000 demographic information as well as LandScan 2005 data that takes into account the 2000 population estimates to provide daytime and nighttime population density estimates. Statewide digital data was obtained from Utah's Automated Geographic Reference Center (AGRC). Hazards data was provided by UGS (landslide), Department of the Interior (wildfire), and Bureau of Land Management (wildfire and dams). The AGRC also provided data on other hazards and infrastructure from their shapefile databases.

Earthquake

Earthquake loss and vulnerability was profiled using HAZUS MH, which is shorthand for Hazards United States. The HAZUS MH Earthquake Model is designed to produce loss estimates for use by federal, state, regional and local governments in planning for earthquake risk mitigation, emergency preparedness, response and recovery. The methodology deals with nearly all aspects of the built environment, and a wide range of different types of losses.

Extensive national databases are embedded within HAZUS MH, containing information such as demographic aspects of the population in a study region, square footage for different occupancies of buildings, and numbers and locations of bridges. Embedded parameters have been included as needed. Using this information, users can carry out general loss estimates for a region. The HAZUS MH methodology and software are flexible enough so that locally developed inventories and other data that more accurately reflect the local environment can be substituted, resulting in increased accuracy. The HAZUS MH methodology and software are robust enough that locally-developed databases are allowed to be substituted into the software. This provides a local jurisdiction with the means to develop a more accurate estimation of their risk to earthquake and the subsequent losses.

Uncertainties are inherent in any loss estimation methodology. They arise in part from incomplete scientific knowledge concerning earthquakes and their effects upon buildings and facilities. They also result from the approximations and simplifications that are necessary for comprehensive analyses. Incomplete or inaccurate inventories of the built environment, demographics and economic parameters add to the uncertainty. These factors can result in a range of uncertainty in loss estimates produced by the HAZUS MH Earthquake Model, possibly at best a factor of two or more.

Dam Failure

Analyses of the total area per county susceptible to dam failure inundation were conducted. State dams and inundation areas for 2006 were provided by the AGRC and federal dams and inundation areas for 2006 were provided by the BOR. The BOR dam inundation data, however, was not mapped due to security risks.

The BOR and state dam failure inundation areas were clipped from each Utah county. The "calculate geometry" function in ArcView 9.2 was then used to calculate the total area of potential dam failure inundation areas. The BOR data provides various dam failure scenarios, such as sudden failure and sunny day failure. The highest potential inundation area was used for each listed BOR dam as to prevent overlapping and multiple summations of BOR dam inundation areas.

The percent total potential inundation areas per county were also calculated to demonstrate how much area per county is at risk to dam failure inundations. This was calculated by dividing the total area of the county by the total potential dam failure inundation area of the county. It is important to note that maps were also created in ArcView 9.2 that visualize this distribution of potential dam failure inundation risk areas per county, and that many of this areas border and intersect population clusters.

The number of people per three arc-seconds (approximately 90m x 70m area) within either a high hazard state or federal dam failure inundation area was calculated to help estimate the possible number of people that could be affected by dam failure inundation. The "select by location" feature found in the ArcView 9.2 software package was used to determine how many people were located within a high hazard dam failure inundation area. LandScan 2005 provided population location data for daytime and nighttime hours and the AGRC and Bureau of Reclamation provided dam inundation data. The Landscan data set was derived by the Oak Ridge National Laboratory utilizing a combination of information such as 2000 census data, proximity of population to roads, slopes, land cover, night-time lights, and other information that is then apportioned to each three second arc-second grid areas. An arc-second is a measure of latitude and longitude used by geographers that equates to approximately 90 meters by 70 meters within the state of Utah. It is important to note that when working with population density data points, a 90m X 70m resolution is at a finer scale than census block data.

In addition, areas that lie within both state and federal high hazard dam failure inundation areas were identified so that populations within these overlapping areas were only counted once. Analyses were also conducted on potential loss to state facilities located in dam inundation areas. Using the "select by attribute" option under the ArcView 9.2 selection toolbar, state facilities within state BOR inundation areas were located, mapped, and the current value of the faculties were summed to estimate potential loss of facilities per county.

Drought

Drought vulnerability rankings are based solely on agricultural information, typically the economic sector hit hardest by a drought. Economic indicators include cash receipts per county from 2004 to 2005, personal income from farming for 2002, number of acres of farmland per county, number of acres of cropland pre county, and number of cattle per county were used to

determine a counties vulnerability to drought. These scores were all normalized and added together to create a vulnerability rating with higher numbers having higher vulnerability.

Flood

Assessing the state's vulnerability to flooding in a quantitative matter proved quite problematic. Utah has limited mapped flood plains and with the exception of Salt Lake and Utah Counties floodplain maps have not yet been digitized. Using NFIP statistics provided limited utility in determining flood vulnerability. Much of Utah's flood risk is either not mapped, mapped as Zone D (indicating the flood risk is undetermined), the city or county does not participate in the NFIP, or because people in the state perceive there is limited flood risk and/or do not believe there is a need to purchase flood insurance. Therefore, much of Utah's flood loss goes unreported. Evidence of this can be seen in the NFIP statistics; in almost 25 years, the National Flood Insurance Program paid out only $4.7 million dollars on 714 claims.

To determined flood vulnerability for each jurisdiction, state floodplain experts were assembled to provide a qualitative vulnerability assessment, classifying each county into a high, medium, or low flood vulnerability rating. Experts included the State Flood Plain Manager, State Hazard Mitigation Officer, the U.S. Army Corps of Engineers, and members of the State Hazard Mitigation Team. Classifications were based on population, in-place flood mitigation, age and accuracy of NFIP maps, dollar amounts of infrastructure values from HAZUS MH, past flood loss, and the potential for future flooding as a result of development pressure.

Wildfire

Analyses of the total area per county susceptible wildfire were conducted using wildfire and state facility data provided by the Bureau of Land Management and the US Department of the Interior through the AGRC. The Oak Ridge National Laboratory provided the Landscan2005 data. Analyses pertaining to the total area of land per county susceptible were first conducted. Layer files of locations classified as high or extreme wildfire areas were constructed using the "select by attribute" option in ArcView 9.2. Using the "geometry calculator" selection in the attribute table, the total amount of square miles per county susceptible to wildfire were calculated and mapped.

Analyses were also conducted on potential loss to state facilities located in high and extreme wildfire risk areas. Using the "select by attribute" option under the ArcView 9.2 selection toolbar, state facilities within high and extreme wildfire risk areas were located, mapped, and the current value of the faculties were summed to estimate potential loss of facilities per county. Landscan 2005 data was used to determine how many people are within high and extreme wildland fire risk areas in each county. The Landscan data set was derived by the Oak Ridge National Laboratory utilizing a combination of information such as 2000 census data, proximity of population to roads, slopes, land cover, night-time lights, and other information that is then apportioned to each three second arc-second grid areas. An arc-second is a measure of latitude and longitude used by geographers that equates to approximately 90 meters by 70 meters in area within the state of Utah. It is important to note that when working with population density data points, a 90m X 70m resolution is at a finer scale than census block data. Analyses of how many people per county are located in high and extreme wildfire risk areas were calculated by utilizing

the “select by location” option under the ArcView 9.2 selection toolbar. The locations of people in relation to high and extreme wildfire risk areas were than mapped for each county and ranked.

Landslide

Similar to analyses were conducted on wildfire and dam failure inundation hazards, the total amount of land area in each county susceptible to landslides. The Utah Geological Survey provided 2007 Landslide data for this analysis.

Analyses pertaining to the total area of land per county susceptible to landslides were first conducted. Layer files of locations classified as having a high landslide potential were constructed using the “select by attribute” option in ArcView 9.2. Using the “geometry calculator” selection in the attribute table, the total amount of square miles per county susceptible to landslides were calculated and mapped. Potential loss to state facilities located in high and extreme wildfire risk areas were then identified. Using the “select by attribute” option under the ArcView 9.2 selection toolbar, state facilities within high or moderate landslide risk areas were located, mapped, and the current value of the faculties were summed to estimate potential loss of facilities per county.
Population density and location data was provided by the LandScan dataset. The Landscan data set was derived by the Oak Ridge National Laboratory utilizing a combination of information such as 2000 census data, proximity of population to roads, slopes, land cover, night-time lights, and other information that is then apportioned to each three second arc-second grid areas. An arc-second is a measure of latitude and longitude used by geographers that equates to approximately 90 meters by 70 meters in area within the state of Utah. It is important to note that when working with population density data points, a 90m X 70m resolution is at a finer scale than census block data.

Landscan 2005 data was used to determine how many people are within high and moderate landslide susceptible area for both daytime and night-time hours. This was completed by utilizing the “select by location” option under the ArcView 9.2 selection toolbar. The locations of people in relation to the location of high or moderate landslide risk areas were than mapped and summed up for each Utah county.

State Owned Faculties

One of the requirements in DMA 2000 is to assess the state owned facilities and there potential vulnerability to particular hazards. The AGRC provided a geocoded list of state-owned facilities and their total current use value. The shapefile used for analyses pertaining to vulnerability of state facilities includes 5,952 facilities.

Table I-5 State Owned Facilities and Their Current Values

County Name	Total # of State Owned Buildings	Current Value
Beaver	49	$11,150,256
Box Elder	146	$284,861,080
Cache	533	$1,182,906,951
Carbon	134	$162,785,121
Daggett	28	$10,740,343
Davis	309	$1,240,208,392
Duchesne	97	$146,405,980
Emery	101	$90,767,423
Garfield	61	$43,473,051
Grand	65	$46,981,354
Iron	198	$396,440,552
Juab	63	$57,733,957
Kane	61	$48,010,847
Millard	85	$108,953,372
Morgan	62	$38,071,621
Piute	25	$14,024,606
Rich	64	$18,323,193
Salt Lake	1,833	$6,929,921,812
San Juan	106	$123,957,855
Sanpete	209	$353,837,580
Sevier	115	$159,322,838
Summit	124	$227,568,051
Tooele	96	$233,897,392
Uintah	125	$152,600,440
Utah	444	$1,435,302,412
Wasatch	150	$101,943,581
Washington	200	$566,831,191
Wayne	33	$11,676,411
Weber	346	$1,191,349,520
N/A*	30	$13,667,653

* 30 facilities were identified as not being associated with any particular county

Provided in Table I-6 is a breakdown by county of the total estimated dollar value exposed natural hazards. This information was derived using HAZUS-MH. Estimated dollar values are provided in millions for the key occupancies classes in Utah along with the number of response facilities, schools, and hospitals.

Table I-6 Total Estimated Exposed Value Per County

County Name	Residential in Millions	Non-Residential in Millions	Schools & Hospitals	Emergency Response Facilities	Total Building Value in Millions
Beaver	$297	$35	7	3	$333
Box Elder	$1,730	$255	29	12	$1,985
Cache	$3,411	$801	33	11	$4,212
Carbon	$983	$149	15	9	$1,132
Daggett	$83	$4	3	3	$88
Davis	$10,276	$1,628	94	36	$11,905
Duchesne	$628	$152	17	3	$780
Emery	$441	$84	10	11	$526
Garfield	$311	$76	11	3	$387
Grand	$386	$89	7	5	$476
Iron	$1,469	$317	15	7	$1,786
Juab	$320	$65	7	4	$386
Kane	$388	$62	8	5	$451
Millard	$504	$95	14	7	$599
Morgan	$302	$67	3	3	$369
Piute	$83	$12	3	1	$96
Rich	$246	$10	4	5	$257
Salt Lake	$40,368	$10,496	306	48	$50,865
San Juan	$527	$82	15	8	$609
Sanpete	$893	$162	15	6	$1,055
Sevier	$821	$154	18	5	$976
Summit	$2,601	$378	16	4	$2,980
Tooele	$1,802	$231	23	11	$2,034
Uintah	$955	$544	11	6	$1,199
Utah	$13,600	$2,712	130	28	$16,313
Wasatch	$860	$111	7	3	$972
Washington	$4,144	$853	34	10	$4,997
Wayne	$148	$19	1	1	$168
Weber	$8,798	$1,566	80	16	$10,365

This ranked list of counties is based on the total building values in Table I-6:

1. Salt Lake	11. Uintah	21. Kane
2. Utah	12. Carbon	22. Garfield
3. Davis	13. Sanpete	23. Juab
4. Weber	14. Sevier	24. Morgan
5. Washington	15. Wasatch	25. Beaver
6. Cache	16. Duchesne	26. Rich

7. Summit	17. San Juan	27. Wayne
8. Tooele	18. Millard	28. Piute
9. Box Elder	19. Emery	29. Daggett
10. Iron	20. Grand	

Estimated Insured Value of State Owned Facilities

For the purpose of estimating potential loss to state owned facilities due to wildfire, landslides, and dam inundation, a state facilities data set was provided by the AGRC. This data set represents 5,963 facilities in the state of Utah that are controlled by the state or by entities of the state of Utah. This number is a great improvement of the data used in the previous assessment, which included approximately 1000 facilities. The dataset was overlaid with the wildfire, landslide, and dam inundation areas to determine how many facilities are vulnerable to these specific natural disasters.

Changes in Development on Lost Estimates

The updated SHMP map section has been greatly updated from the original plan. This current plan includes updates, improvements, and additions to the maps section. Better and updated shape files were available for the 2007 update for many of the natural hazards that were not available in the 2004 analyses. In addition, daytime and nighttime population density data were incorporated into the risk analysis in order to assist in the identification of heavily populated areas that intersect high hazards regions. Landscan data was used to identify population used in the maps and risk analyses. This allows us to have a better understanding of the lost estimates for Wildfire, Dam Failures and Landslides. The previous plan did not contain population density in any of the maps.

Limitations

Challenges in conducting hazard identification and impact analyses include lack of data availability, lack of current and frequently updated data, and insufficient tools available to conduct detailed and thorough analyses. Fortunately for this assessment, much of the hazard data was updated within the past year. The following items would be useful in future planning processes:

- Digital flood plain maps
- Available and updated County Assessor data from all 29 counties.
- A better method and model that can be used in predicting future losses.
- Funding

Future analysis

Advances in GIS data and analysis methods are starting to be use by state agencies. In the future mitigation plans and revisions will include:

- Detailed state owned facilities loss information
- Potential avalanche slopes
- More detailed local specific wildfire loss information.
- Data and methodology to address potential social vulnerability issues in disasters.